

Observations, and Preliminary Soil Data on the Impact of DryJect on Fairy Ring Symptoms and Infiltration Rates, 2008

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Preface: Fairy ring is an intractable fungal disease of turfgrass. The causal agents of fairy ring are soil-borne basidiomycetes fungi. Visual symptoms in turfgrasses are categorized into three distinct “types”. Type I fairy ring symptoms are the most severe, with wilted, necrotic, and dead turf appearing in rings or arcs. These sites are associated with water repellent soil conditions, extremely high concentrations of ammonium nitrogen in the soil root zone, as well as low soil moisture content. Type II symptoms are the visual appearance of circles or arcs of dark green, luxuriant turf. The turf responds as if receiving a dose of nitrate nitrogen, which is provided by the breakdown of organic matter by the fairy ring fungi. Type III symptoms are mushrooms or basidiocarps growing in rings or semi-circles, and these mushrooms can appear alone or in groups or clusters (photo above). Also, mushrooms are often observed growing along the edges of type I or type II rings. It is also possible to have more than one “type” of fairy ring at the same time in the same site. Successful management or control of fairy ring symptoms in turfgrasses maintained on golf courses, especially type I symptoms, has been inconsistent. Management using chemicals is very expensive.

In recent years, many superintendents and agronomists have commented that fairy ring is the most problematic disease in turfgrass systems. Although, many superintendents routinely adjust management practices to combat fairy ring, little documented information is available on the impact of soil modification on the symptom expression of fairy ring. This could be an extremely important aspect in the management of this disease that has been overlooked in the past.

Fairy Ring Observations at Philadelphia Country Club, Gladwyne, PA

The most problematic disease of fairway turf at the Philadelphia Country Club is fairy ring. The rings are present all year long and during late June through September, many of the rings will advance from type II to type I and collapse. One of the most

problematic areas on the entire property is number six and seven of the Centennial Course. The fairy rings are visible as type II rings for the entire year and routinely wilt and collapse by mid-summer, annually.

In the spring of 2007, a portion of the seventh fairway on the Centennial Course was DryJected one, two and no times over using Profile Fairway and Field Grade. There were three separate treated areas (i.e. one time over, two times over, and not treated). It is important to note that the rings were present in the entire treated area at this time and were type II.

Observations from 2007 and 2008 have indicated that the treated (i.e. DryJected with Profile) areas had significantly less wilting and collapse of turfgrass. Therefore, these areas had superior quality, when compared to the other areas of the fairway that had not been injected. Also, on various evaluation dates throughout 2007, it appeared that the areas that had received the two times over DryJect injection, had significantly less severe fairy rings, when compared to the single time over. It is important to note, that the areas were measured and marked out using sprinkler heads. These were all observations made by the superintendents (Phil Read and Mike McNulty) and myself.

2008 Demonstration Trial Area:

In the spring of 2008, another area was DryJected with Profile on the lower portion of the eighteenth fairway on the Spring-Mill Course at Philadelphia Country Club. This is another problematic area for type I and I fairy ring symptoms during the entire growing season. The left hand side of this fairway is an historic spot for rings to advance from type II (green rings) to type I (dead, collapsed turf) rapidly during the summer months. Therefore, the left hand side of this fairway was chosen as one of the injection sites.

From late July through late September, weather in the Gladwyne, PA area was marked by cooler than normal ambient air temperatures, and extremely dry conditions. For the month of August, less than 0.5 inch of rainfall was recorded on the property at Philadelphia Country Club. These environmental conditions are ideal for the fairy ring symptoms to advance to type I.

By the middle of August, there again were distinct observational differences in 1.) the amount of fairy ring in the DryJected areas on the left hand side of the eighteenth fairway, when compared to the historic amounts, and 2.) in the untreated portions of that fairway new rings were showing up and advance rapidly to type II and I.

Therefore, a pilot soils study was conducted to see if there were any differences in the physical characteristics of the soil. It is important to note, that in the treated areas, there was still minor symptom expression (i.e. green stimulated rings), whereas the symptoms in the untreated areas were advanced (i.e. very bright green, very stimulated, wilted and collapsed, sunken into canopy).



Photo taken on 8 September when the undisturbed cores were pulled. The area to the left was DryJected with Profile and the area to the right was untreated. Notice the rings area wilting and somewhat depressed. The area to the right was an historically bad spot for fairy ring.

How this was done:

Three different undisturbed soil cores were removed from three separate areas on the eighteenth fairway. All samples were sent to International Sports Turf Research Center, Inc (Lenexa, KS 66215) for evaluation.

Sample	Description
Fairy Ring Treated with DryJect	Core was removed from a portion of the fairway where DryJect was performed the spring and had minor green stimulation. Symptoms were visible but acceptable to a golf course superintendent.
Fairy Ring Not Treated	Core was removed from a portion of a fairy ring that was not DryJected, and was in type I stages. These symptoms would be completely unacceptable.
No Fairy Ring, No Treatment	No DryJect had been performed in this area, no fairy ring symptoms were present. This could be considered the standard.



Undisturbed soil cores were removed on 8 September 2008 to better understand the physical soil aspects of the observations made during 2007 and 2008. This photo shows the not-treated, no fairy ring sampling area. The turf was 'Princeville' creeping bentgrass. Samples were sent to International Sports Turf Research Center, Inc (Lenexa, KS 66215) for evaluation.

Results

Table 1. Infiltration rate, subsurface air capacity, water porosity, bulk density and water holding as influenced by DryJect using Profile.

Sample	Infiltration Rate (in/hr)	Subsurface Air Capacity	Water Porosity	Bulk Density	Water Holding
Fairy Ring Treated with DryJect	0.88	11.77%	50.83%	1.12	45.57%
Fairy Ring Not Treated	2.27	16.57%	45.90%	1.03	44.71
No Fairy Ring, No Treatment	5.08	12.2%	50.04%	1.10	45.55%
Recommended Ranges	>2.0	> 12%	<35%	1.35-1.45	<30%

Table 2. Percent organic content at various depths to 4 inches as influenced by DryJect using Profile.

Sample	¼ to 1 inch	1 to 2 inch	2 to 3 inch	3 to 4 inch
Fairy Ring Treated with DryJect	8.50%	7.44%	6.96%	3.84
Fairy Ring Not Treated	8.0%	6.36%	5.10%	5.02%
No Fairy Ring, No Treatment	7.84%	6.64%	5.12%	4.29%
Recommended Ranges	1.5 to 3.0%	1.0 to 2.0%	0.5 to 2.0%	0.5 to 2.0%

No significant differences were observed in the root mass (5/8 inch) and feeder roots (<3.0 inches) of any of the samples submitted. Recommended ranges for root mass is

greater than 0.5 inch with feeder roots at least 3.5 inches with medium density. Also, no significant or consistent differences were found in the particle size analysis of the three samples. This may be due to only a single injection of Profile using the DryJect method. One could potentially see a difference with multiple injections in the particle size analysis.

Infiltration Trial:



Number seven fairway of the Centennial Course on day of infiltration test. The nearest portion of this fairway has never received any DryJect treatment and fairy ring symptoms are still apparent. The far portion of the fairway has received either one or two times over with DryJect injecting Profile and no fairy ring symptoms are present. Historically, this entire fairway had major Type I and II symptoms, year-round. These treatments were applied in May of 2007 and the reduction in symptoms expression is still

Data in table 1 show the infiltration rates of the three treatment areas. One major concern of the ISTRC data was that the infiltration rate in turf DryJected with Profile (i.e. Fairy Ring Treated with DryJect) was that that turf had the lowest infiltration rate (i.e. 0.88 inch/hr. These data were contrary to other data and observations since the incorporation of Profile soil amended should increase water movement through the soil profile. A bridging study was conducted on 31 December 2008 to quantify infiltration rates on two different DryJected areas at Philadelphia Country Club.

The first site was the seventh fairway of the Centennial Course and the other was the eighteenth fairway of the Spring Mill Course. Infiltration measurements were obtained using three double ring infiltration (one is shown in photo above). The rings were placed 2 inches into the soil and water was poured until the rings were completely full. Measurements were taken initially (i.e. top of device) and a five minutes following infiltration. The five minute readings were then multiplied by 12 to obtain the infiltration ring in inches per hour (in/hr). Ten individual measurements were obtained in each of the treated areas (i.e. two different fairways; 3 on Centennial Course and 2 on 18 Spring Mill Course). The means of the ten readings were then subjected to ANOVA and significantly different means were separated using Tukeys's protected LSD. Data are shown in tables 3 and 4.

Table 3. The impact of Dryjecting with Profile one times, two times and not treated on infiltration rates of the seventh fairway of the Centennial Course at Philadelphia Country Club, 31 December 2008.

Treatment	Infiltration Rate (in/hr)
DryJected Once with Profile	3.970 b
DryJected Twice with Profile	4.580 a
No Treatment	3.892 c
Treatment Prob(F)	0.0001

* Data are the mean of ten measurements in the treated areas of the seventh fairway of the Centennial Course at Philadelphia Country Club. Treatments were applied in early May of 2007.

** Means in a column followed by the same letter do not significantly differ ($P=.05$, Tukey's HSD)

Table 4. The impact of Dryjecting with Profile one time and not treated on infiltration rates of the 18th fairway of the Spring Mill Course at Philadelphia Country Club, 31 December 2008.

Treatment	Infiltration Rate (in/hr)
DryJected Once with Profile	3.498 a
No Treatment	3.460 b
Treatment Prob(F)	0.0224

* Data are the mean of ten measurements in the treated areas of the 18th fairway of the Spring Mill Course at Philadelphia Country Club. Treatments were applied in May of 2008.

** Means in a column followed by the same letter do not significantly differ ($P=.05$, Tukey's HSD)

Results of the Infiltration Rate Bridging Trial:

Volumetric water content was taken in the location of the double ring infiltrometer prior to infiltration measurements and no differences were observed. Soil moisture in the trial area ranged from 40-45% on both of the fairways. Data for the infiltration trial conducted on the seventh fairway of the Centennial Course are shown in table three. This treatment was applied in May of 2007 and measurements were taken on 31 December 2008. These data reveal that Dryjecting with Profile significantly increase water infiltration rates and that there was a significant rate effect (i.e. twice over had a greater infiltration rate, when compared to once over). The non treated turf had an infiltration rate greater than 2.0 in/hr (acceptable range as indicted by ISTRC standards). The highest infiltration rate was measured in plots receiving twice over (4.5 in/hr). Data from this site indicate that Dryjecting with Profile can increase infiltration rates for up to 19 months following treatment.

The eighteenth fairway was DryJected with Profile in May of 2008 and measurements were taken 7 months later. These measurements indicate that Dryjecting

once over significantly increase the infiltration rate by 0.38 in/hr (table 4). Agronomically, this would help to increase rooting depth, drying time, and playability of this fairway turf.

Future trials should measure infiltration rates, prior to, and at pre-determined times following DryJecting. For example, a baseline measurement would provide a standard and measurements at one, two, five, twelve and twenty four months would give a better understanding of the long term impacts of these treatments. Data from the current trials indicates that we see an increase in infiltration from a single time over and these effects last up to 19 months (or longer) following application. Future trials should be designed to quantify the impacts of infiltration rate and thatch following treatment.

Overall Conclusions and Discussion from Both Trials: The most important data from this demo pilot trial is shown in table 1, above. No concrete findings were exposed using the pilot sampling method. One aspect that does stick out is the water porosity (capillary). The measure water porosity was slightly greater in the fairy ring-injected soil (50.83%), when compared to the untreated soil (50.04%). However, the water porosity was almost 5% Higher in the fairy ring injected soil, when compared to the fairy ring not treated (45.90%). This may help to explain how and why the fairy ring symptoms were present, however, not causing significant wilt and collapse of the creeping bentgrass turf in the DryJected turf. Profile should help to hold more moisture when compared to other amendments such as straight sand. Data from the intact core sampling revealed that the DryJected soil on the eighteenth fairway had the lowest infiltration rate (0.8 inch/hour), when compared to the other two which were 2.27 and 5.08 inch/hour. That sample, however, may be an aberration due to the fact that an extensive field infiltration trial revealed that the infiltration rates for the entire fairway were greater than 3.460 (Not treated). It is possible that the core used was not a representative sample from the site which regards to infiltration rates. Agronomically, data from the field infiltration trial indicate that these is a significant effect on infiltration rates following DryJecting with Profile. These benefits would include increased rooting, increase water movement through profile, increase in surface firmness and playability as well as a decrease in thatch/mat layers. Data also indicate that DryJecting twice over still increases infiltration more than once over. This is an important aspect when considering long-term approaches to fairy ring management and playability. The annual or bi-annual use of DryJecting with Profile may continue to increase infiltration rates.

Other explanations for these observations could include many other reasons. One explanation could be better rooting in the turfgrass treated with DryJect using Profile. The channels created in the spring time may allow for better root elongation. Plants with better roots may be less affected by hydrophobic soil conditions. It is also possible that the thatch layer is impacted. Thatch can play a huge role in hydrophobic layers.

Another possible explanation is the physical disruption of the fungi layer in the soil. By creating a solid channel of Profile in the soil, it may be less likely to colonize the soil rapidly creating the wilt symptoms. On the contrary, though, we rarely see the injection of straight sand affect fairy ring symptoms of greens for long periods of time. It appears that the suppression of fairy ring symptoms is greater with a material like Profile. Overall, fairy ring symptoms were reduced in the areas receiving the spring time injection of Profile using the DryJect machine. Further research is needed to elucidate the

intereaction between the DryJect process and the reduction (i.e. suppression) of fairy ring symptoms in fairway turf. It is likely to also play a role in the suppression of fairy ring in other turfgrass systems such as greens and tees. Future research should be more in-depth looking at chemical and physical properties for days, months and years. Also, volumetric water content should be regularly measured in the injected versus un-injected. At this time, it appears that there is a relationship between the DryJect injection of Profile and the suppression of fairy ring, however, it may be a complex interaction of environmental, chemical and physical factors.